IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Bertero et al.

Title: Magnetic Recording Media with Improved Exchange Coupling

Serial No.: 10/075,123   Filed: 2/12/02

Examiner: Kevin M. Bernatz   Art Unit: 1773

Docket No.: K2000023

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION

I, Gerardo Bertero, declare:

1. I earned my Metallurgical Engineering degree at the Catholic University of Cordoba (in Argentina) 1986. I earned my MS degree in material science and engineering at Vanderbilt University in 1989. I earned my Ph.D. degree in material science and engineering at Stanford University in 1995. Since 1994, I have been employed as an engineer at Komag, Inc., specializing in the field of magnetic recording media.

2. I am a coinventor named in U.S. Patent Application 10/075,123 (hereafter the Application). I have read and understand the '123 application. I have also read and understand the article entitled "Advanced Media for Extremely High-Density Longitudinal Magnetic Recording" (Proceedings of 6th International Symposium on Magnetic Materials, Processes and Devices, Phoenix, Oct. 2000) by Acharya et al. (hereafter Acharya). I understand that the Examiner has taken the position that Acharya inherently anticipates claims 2, 9, 13-15, 17-21 and 40-49 of the Application. The

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coinventors in the Application have performed experiments demonstrating that this is incorrect, and in fact, Acharya does not anticipate these claims.

3.   We built a magnetic recording medium comprising an Al alloy substrate, a NiP layer electroless-plated onto the substrate, a Cr alloy underlayer, a first ferromagnetic Co alloy layer, a Ru intermediate layer and a second ferromagnetic Co alloy layer. The first and second ferromagnetic layers were antiferromagnetically coupled. In other words, this disk had a structure in accordance with Acharya Fig. 4(a). We then collected data concerning this disk. Some of these data are set forth in Application Fig. 9A. Although the disk of Fig. 9A is in accordance with Acharya, it does not exhibit the characteristics required by claims 19-21 and 47. Further, a disk drive incorporating the disk of Fig. 9A would not exhibit the characteristics required by claims 2, 9, 13-15, 17, 18, or 46. Further, operation of such a disk drive would not result in the performance of acts required by claims 40-45, 48 or 49.

4.   Claim 13 states:

the relationship between the dynamic coercivity of the lower magnetic layer structure and the exchange field is such that after termination of application of a write magnetic field to the usable locations on the disk the portion of the lower magnetic layer structure at said locations achieve substantially their steady magnetization state within the time required for one revolution of said disk.

For reasons set forth below, Acharya's disk does not inherently meet this limitation.

5.   In the disk of Fig. 9A, the amount of time it takes a location in the lower magnetic layer to achieve substantially its steady state depends in part on the size of the

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magnetized region in the corresponding upper magnetic layer. In a magnetic disk drive, the magnetized regions have varying sizes. The larger the magnetized region, the longer it takes for the corresponding portion of the lower magnetic layer to substantially reach its steady state. (This is because the demagnetization field is smaller if the magnetized region is larger.)

6.   One can discern from Fig. 9A that an Acharya disk, being incorporated into a disk drive, would not inherently meet the above-quoted limitation from claim 13 because the disk would contain regions which would not substantially achieve their steady state within the time required for one disk revolution.

7.   One might be tempted to argue that Fig. 9A implies that one could conceivably achieve the conditions of claim 13 by taking an Acharya disk and recording a data pattern that resulted only in very tiny magnetized regions that were sufficiently small so as to achieve substantially steady state magnetization within one revolution. However this is not how magnetic disks are used. Further, Applicants achieve substantially steady state magnetization not merely by using only very tiny magnetized regions but by employing the claimed relation between the exchange field and the dynamic coercivity of the lower magnetic layer.

8.   For the reasons set forth above, Acharya does not meet the limitations of claim 13. Further, for these reasons, Acharya does not inherently meet the limitations of the other claims alleged by the Office Action to be anticipated by Acharya.

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9.   I understand that the Examiner has alleged that

Igarashi et al. teach an antiferromagnetically coupled recording medium wherein the lower magnetic layer (layer 12) can comprise CoCrPt alloys, as well as known soft magnetic materials "FeNiCo, CoFeTa, NiTa, CoW, CoNb, ... FeN" (Paragraph 0036).

Office Action, page 11. This is incorrect. While it is possible to construct an alloy

including FeNiCo to be magnetically soft (depending upon the concentration of the

various elements within the alloy), it is also possible to construct the alloy so that it is not

magnetically soft. The same is true of the other alloys listed in Igarashi paragraph 36.

10.   One skilled in the art, reviewing Igarashi, would understand that Igarashi intended

that he should use alloys that are not magnetically soft. One reason for this is that

Igarashi paragraph 36 teaches using FeNiCo, CoFeTa, NiTa, CoW, CoNb or FeN to form

ferromagnetic recording layer 11. One would not make a magnetic recording layer out of

a soft magnetic layer because such a recording layer could not properly store data.

Accordingly, Igarashi could not possibly intend that these materials should be

magnetically soft.

11.   A second reason that it is clear that Igarashi does not intend that the above-

mentioned alloys should be magnetically soft is that Igarashi paragraph 41 teaches that

the magnetic anisotropy energy of layer 12 should be greater than 0.4 times the magnetic

anisotropy energy of layer 11. This means that layer 12 should not be magnetically soft.

12.   I understand that the Examiner alleges that

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> Carey et al. teach that materials meeting applicants' claimed Markush limitations
> are known equivalent (sic) to the alloys listed by Igarashi et al. (Paragraph 24:
> "In addition to CoFe, other magnetically permeable materials suitable for the FM
> layers are alloys of CoNiFe, FeCoB, CoCuFe, NiFe, FeAlSi, FeTaN, FeN, FeTaC,
> CoTaZr, CoFeB, and CoZrNb.

Office Action, pages 11-12. This is incorrect—Carey's alloys are not equivalent to

Igarashi's materials. Carey teaches magnetically permeable alloys used for vertical

magnetic recording. These alloys are not the same as Igarashi's alloys, nor are they

equivalent, nor do they have the same characteristics. As mentioned above, Igarashi

makes clear that his alloys are not magnetically soft. In contrast, Carey's alloys are

magnetically soft. They are not equivalent to or interchangeable with Igarashi's alloys.

They have different magnetic characteristics and cannot be substituted for one another.

13.   I understand that the Examiner rejected claims 27-27 "as being unpatentable over

Acharya et al. as evidenced by Tam et al. ... and further in view of Richter et al. (IEEE

Trans. Mag., 34(4), 1998, 1540-1542) and Richter et al. (IEEE Trans. Mag., 37(4), 2001,

1441-1444)." Office Action page 9. I have read and understand the Richter articles, and

I conclude that the position taken by the Examiner is incorrect. Claim 27 recites "the

dynamic coercivity of the lower magnetic layer structure being greater than or equal to

zero but less than the exchange field between the upper and lower magnetic layer

structures." The discussion below focuses on this limitation.

14.   The Examiner states

> Acharya et al. further disclose that the coercivity of the lower layer must be less
> than the exchange force inorder (sic) to enable switching in a positive field,
> including specific embodiments wherein the coercivity is less than half the
> exchange force (Figure 7a and 8 and page 8). Finally, Acharya et al. disclose the

behavior of the dynamic coercivity with respect to the measurement time in Figure 5, though this is for the entire medium and not for each layer individually (see also pages 6-7).

Acharya et al. fail to disclose controlling the dynamic coercivity ... nor the short-time coercivity ... such that they are less than the exchange force (or less than half the exchange force).

However, Richter (both references) teach that it is desired to minimize short-time coercivity and the dynamic coercivity to insure a small difference between the writing coercivity and the storage (long-time) coercivity inorder (sic) avoid writing problems (sic) by avoiding the superparamagnetic limit associated with high coercivity values at short times.....

Office Action, pages 9-10. I believe the Examiner misunderstands these references.

15.   Referring to Exhibit A, during writing to a region R of a magnetic disk D, a read-write head H applies a magnetic field M which forces magnetization in lower and upper layers L1, L2 to align in the direction of field M (see arrows A1 and A2). During writing, read-write head H is typically over region R for a very brief time period (e.g. 10 ns). Accordingly, the dynamic coercivity of upper layer L2 is a very important parameter because it controls whether head H can write to layer L2. In other words, the dynamic coercivity determines whether one can write to the disk during that brief time period.

16.   Eventually, the magnetization direction of layer L1 switches due to the antiferromagnetic coupling between layers L1 and L2 (see arrow A1' in Exhibit B). The switching of layer L1 occurs after the write process has terminated, i.e. after region R is no longer close to read-write head H. Because layer L1 does not switch to direction A1' during the brief time that head H is close to region R (e.g. less than 10 ns), the factors that

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militate in favor of reducing the dynamic coercivity of layer L2 are inapplicable to layer L1.

17.   There is nothing in Richter to teach or suggest that it is desirable to have a low dynamic coercivity for layer L1. All of Richter's teachings pertaining to a low dynamic coercivity pertain to layer L2, and those teachings are inapplicable to layer L1. Nor is there anything in Acharya to teach or suggest that layer L1 should have a low dynamic coercivity.

18.   Acharya provides layer L1 to promote thermal stability in his magnetic disk. Reducing the dynamic coercivity of layer L1 would not promote thermal stability of Acharya's disk. Therefore, one skilled in the art, given Acharya, would have no reason to reduce the dynamic coercivity of layer L1.

19.   Applicants reduce the dynamic coercivity of layer L1 for reasons that have nothing to do with any consideration raised or discussed by Acharya or Richter. Applicants desire to have layer L1 achieve its steady state magnetization within about one disk revolution. (See, for example, claim 13.) Neither Acharya nor Richter teach or suggest that there is any reason to do this.

20.   As indicated above, when head H writes to region R of disk D, in a typical disk magnetization direction A1 of layer L1 at region R is temporarily forced to align in the direction of write field M. There is nothing about this phenomenon that suggests making

the dynamic coercivity of layer L1 less than the exchange field (which is caused by the antiferromagnetic coupling between layers L1 and L2). First, forcing the magnetization direction A1 of layer L1 to align in the direction of field M is merely a by-product of other design considerations. After writing, the magnetization direction of layer L1 flips from direction A1 to A1'. There is nothing useful or important, in and of itself, about the fact that layer L1 briefly and temporarily magnetizes in direction A1. In particular, one skilled in the art, making a magnetic disk, has no reason to facilitate causing the magnetization direction of layer L1 to be in direction A1.

21. Second, write field M is generally much greater than the exchange field. Therefore, the fact that field M can force magnetization direction A1 to align in the direction of field M says nothing about the relation between the exchange field and the dynamic coercivity of layer L1. Thus, again, there is nothing that suggests to one of ordinary skill in the art that the dynamic coercivity of layer L1 should be less than the exchange field.

22. The Office Action alleges

> it would have been obvious to one of ordinary skill to minimize the dynamic
> coercivity and the short-time coercivity values since the long-time coercivity
> values must be minimized to enable switching in a positive field and by insuring a
> flat dynamic coercivity curve, the AFC media can avoid the superparamagnetic
> limit and achieve an improved SNR.

Office Action, page 10. The cited art does not advocate minimizing dynamic coercivity. If one were to make the dynamic coercivity of layer L2 arbitrarily small, one would be unable to store data in Acharya's disk or Richter's disk. Rather, one wants to make the

dynamic coercivity of layer L2 as high as possible, as long as it is not too high for writing to occur. Therefore, the premise of the above-quoted argument contained in the Office Action is incorrect.

23.   I hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 USC 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Respectfully submitted,
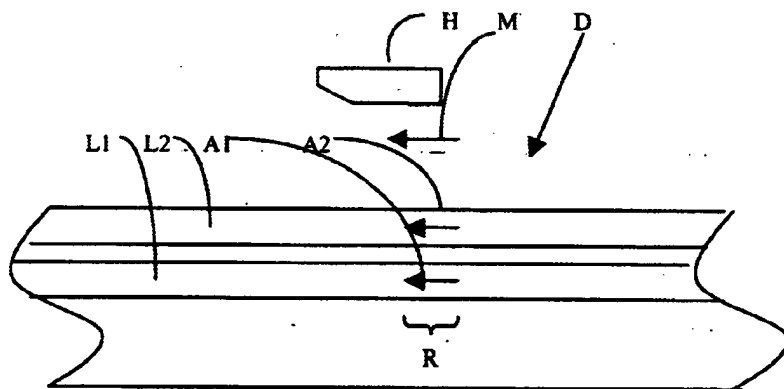
Gerardo Bertefo

July 14, 2004
Date

EXHIBIT A

H   M   D

L1 L2 A1   A2

R

EXHIBIT B

D

L1 L2   A2

A1'

R

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